

The turrilitid ammonoid *Mariella* from Hokkaido — Part 1

(Studies of the Cretaceous ammonites from Hokkaido and Sakhalin—LXXXV)

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Abstract. Three species of the genus *Mariella* (Turrilitidae) from the Lower Cenomanian (Cretaceous) of Hokkaido are described. They include the two widespread species, *M. (M.) dorsetensis* (Spath, 1926) and *M. (M.) oehlerti* (Pervinquière, 1910). The third species, *M. (M.) pacifica* sp. nov., is somewhat similar to but distinguished from *M. (M.) oehlerti*. It is also compared with some other species. The problem of dimorphism in the turrilitid ammonoids is discussed.

Key words: Cenomanian, dimorphism, Hokkaido, *Mariella*, Turrilitidae

Introduction

Ammonoids of the family Turrilitidae have been recorded from various regions of the world. They occur in the mid-Cretaceous (Albian and Cenomanian) and include a number of widespread species which are useful for biostratigraphic zonation and correlation. Some of them are, however, apparently endemic. Turrilitids would be also useful to investigate some aspects of palaeogeography and palaeoenvironments during mid Cretaceous times.

Aside from several stratigraphic papers in which some turrilitid species are listed or briefly mentioned, very few species have been hitherto described from Japan, although such a magnificent example as *Turrilites komotai* Yabe, 1904 (p. 7, pls. 1, 2) [now referred to *Hypoturrilites*] was once reported. In our present knowledge ammonoids of the Turrilitidae occur fairly commonly in the mid Cretaceous sediments of certain biofacies in Hokkaido. A rare but important occurrence of *Mesoturrilites* from Hokkaido has been recently reported (Matsumoto and Inoma, 1999). More species of the family are to be described successively. In this paper three species of the genus *Mariella* are described, of which two are well known and widespread. The third species is regarded as new and has not been known elsewhere.

Incidentally, T. M. had opportunities to examine some specimens at the Natural History Museum, London, and several other overseas institutions. Moreover, W. J. Kennedy kindly sent several specimens to Kyushu University as reference material.

Geographic and stratigraphic setting

The specimens dealt with in this paper were obtained mainly from the Soeushinai area [Shumarinai-Soeushinai area by some authors] of the Teshio Mountains, northwestern Hokkaido. The Cretaceous strata are exposed in the Shumarinai Valley, the Sounnai Valley and the smaller rivulets, such as the Kyoei-Sakin-zawa and the Sanjussen-zawa, which are all tributaries of the River Uryu, and also in the upper reaches of the River Kotanbetsu. This area was geologically mapped by Hashimoto *et al.* (1965) and has been recently reinvestigated by Nishida *et al.* (1992, 1993, 1996, 1997, 1998a, 1998b). The localities where megafossils and microfossils were collected are pinpointed in the papers by Matsumoto and Inoma (1975) and Inoma (1980) and, furthermore, in a number of route maps of the stratigraphic papers by Nishida *et al.* (1992, 1993, 1996–1998a, b). Moreover, a locality guide is to be given as an Appendix to this paper.

As has been clarified by the above authors, a thick series of strata comprehensively called the Middle Yezo Subgroup of late Albian through Turonian age is extensively distributed in this area. The conformably underlying Lower Yezo Subgroup and the transitionally overlying Upper Yezo Subgroup are partly observable in the area. In a revised scheme of Nishida *et al.* (1996, fig. 10) the Middle Yezo Subgroup in this area is lithostratigraphically subdivided into the Members My1 to My8 in ascending order. The Members My1 and My2, together with the uppermost portion of the Lower Yezo Subgroup, are Upper Albian, the Member My3 is Lower Cenomanian, and the Members My4 and My5 represent the rest of the Cenomanian. The age correlation is based on the assemblage of ammonoid and inoceramid species and also on that of some microfossils (Nishida *et al.*,

1992, 1993, 1996–1998a, b). As there is a lateral change in the lithofacies and thickness of the members from place to place, boundary planes of the successive members may be somewhat diachronous in some cases.

The turrilitid ammonoids have been obtained from the Members My2, My3 (most commonly) and My5 and also the upper part of the Lower Yezo Subgroup. These members consist primarily of mudstones, which are sometimes sandy or have intercalated sandy layers and laminae.

Conventions

Repository.—The illustrated and/or measured specimens are registered in the following institutions which are indicated by the abbreviated symbols as follows:

GK : Type Room, Department of Earth and Planetary

Sciences, Kyushu University, Hakozaki, Fukuoka

GS : Geological Collections, Faculty of Culture and Education, Saga University, Saga

MCM : Mikasa City Museum, Mikasa, Hokkaido

TKD : Institute of Geosciences, Tsukuba University, Tsukuba [reconstitution of the Tokyo Kyoiku Daigaku]

UMUT : University Museum, University of Tokyo, Hongo, Tokyo

Morphological terms.—For the morphological terms to describe the turrilitid ammonoids, we follow those used by Wright and Kennedy (1996). Setting the apex of the turrilid shell at the top, the terms upper and lower or adapical and adoral [=abapical] are defined and the rows of tubercles or ribs on the face of each whorl are described in descending order as the first, the second and so on. The term flank (see Förster, 1975) may be used for the exposed whorl face of

Wright and Kennedy (1996).

Palaeontological descriptions

Order Ammonoidea Zittel, 1884

Suborder Ancyloceratina, Wiedmann, 1966

Family Turrilitidae Gill, 1871

Genus *Mariella* Nowak, 1916

Type species.—*Turrilites bergeri* Brongniart, 1822 (p. 395, pl. 7, fig. 3) by original designation (Nowak, 1916, p. 10).

Remarks.—Wright and Kennedy (1996, p. 330) have given an ample generic diagnosis and discussed problems of nomenclature. The genus includes the two subgenera, *Mariella* (*Mariella*) Nowak, 1916 and *Mariella* (*Wintonia*) Adkins, 1920, the latter of which is a senior synonym of *Mariella* (*Plesiotturrilites*) Breistroffer, 1953 (see Wright and Kennedy, 1996, p. 331). An undoubted example of *M. (Wintonia)* has not been so far found from Japan, whereas there are a number of specimens from Hokkaido which are referable to at least eight species of *M. (Mariella)*.

Mariella (Mariella) dorsetensis (Spath, 1926)

Figure 1

Turrilites bergeri Brongniart. Sharpe, 1857, p. 65, pl. 26, fig. 11 only.

Turrilites dorsetensis Spath, 1926, p. 429.

Mariella dorsetensis (Spath). Spath, 1937, p. 513; Marcinowski, 1970, p. 431, pl. 3, fig. 1; Seyed-Emami and Aryai, 1981, p. 26, pl. 6, figs. 5, 6.

Paraturrilites lewesiensis (Spath). Benavides-Cáceres, 1956, p. 436 (pars.), pl. 40, figs. 8, 9 (?).

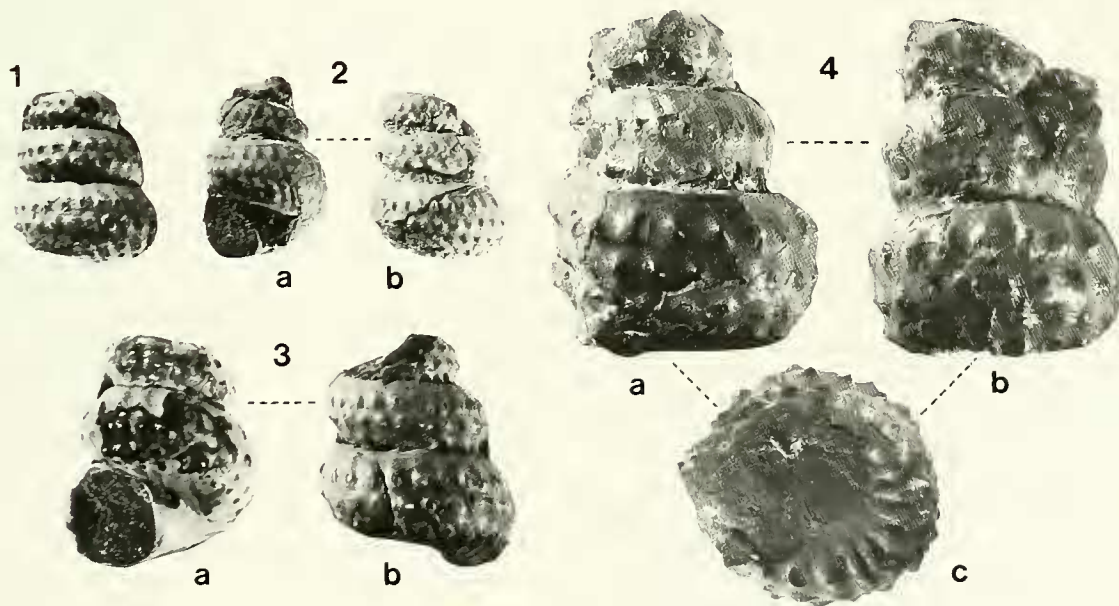


Figure 1. *Mariella (Mariella) dorsetensis* (Spath). 1. GS. 180, $\times 1$. 2a, b. GK. H8504, two lateral views, $\times 2$. 3a, b. GS. G180, two lateral views (different sides from 1), $\times 2$. 4a–c. GS. G182, two lateral and basal views, $\times 1.5$.

Mariella (Mariella) dorsetensis (Spath). Atabekian, 1985, p. 35, pl. 6, figs. 6, 9; Wright and Kennedy, 1996, p. 344, pl. 100, figs. 5, 11, 17, 19, 22, 25; pl. 102, fig. 7; text-figs. 136B, E (with full synonymy).

Holotype.—BMNH. C3834, figured by Sharpe, 1857, pl. 26, fig. 11 and named as *Turrilites dorsetensis* Spath, 1926, p. 429 (by monotypy).

Material.—GS. G180 (Figure 1-1, 3) and GS. G181, both from loc. R905 [=YKC080621b], Hotei-zawa; GK. H8504 (Figure 1-2) from loc. R518p5, East Suribachi-zawa; GK. H8505 from loc. R438p, GK. H8506 from loc. R433p, and TKD 30081A, B from loc. 81007, in the upper reaches of the Suribachi-zawa; TKD 30080A-D from loc. 71204 in the middle course of the River Shumarinai; GS. G182 (Figure 1-4), from loc. YKC060824, Sanjussen-zawa. These are all from the Lower Cenomanian Member My3 of the Soeushinai area.

Description.—The available specimens are all small and incomplete, as seen in the illustration (Figure 1). In general, the apical angle is acute (20–25° in our estimation). The whorl is rounded in section, showing a moderately or broadly convex outer face; the whorl junction is well defined and crenulated.

The tubercles in four rows are of moderate density and number 20 to 25 per whorl in each row. The tubercles on the outer whorl face are disposed slightly obliquely in three rows at subequal intervals and of nearly equal moderate intensity. The tubercle of the first row is elongated upward to a distinct rib on the upper face of the whorl. In some specimens the fourth tubercle is slightly smaller than the others and close to the third one, although it is beyond the lower whorl seam. On the lower whorl face ribs run from the third row tubercles to the narrow umbilicus by way of the fourth row tubercles, showing a gentle curvature.

Septal sutures are partly exposed (GK. H8505).

Comparison.—The above-described specimens from Hokkaido are well comparable with the holotype and other examples of *M. (M.) dorsetensis* from England (Wright and Kennedy, 1996, pl. 100, figs. 5, 11, 17, 19, 22, 25) and also previously illustrated specimens from several regions of the world (see synonymy list). Affinities with other allied species are discussed below, together with some remarks on questionable points.

Occurrence.—As for material. This species has been reported from the Lower Cenomanian of southern England, northern France, Poland, Turkmenistan, Iran, Madagascar and Peru (see synonymy list).

Discussion.—*M. (M.) dorsetensis* is similar to and could be interpreted as a descendant from *M. (M.) bergeri* of the uppermost Albian. The apical angle of the former is smaller than that of the latter. In fact the apical angle of *M. (M.) bergeri* is recorded as 33–38° by Spath (1937, p. 511) and an example of Pictet and Campiche (1862, pl. 58, fig. 2) reillustrated by Renz (1968, pl. 18, fig. 4) gives 34°, as compared to the 20–25° of *M. (M.) dorsetensis*. On the average the tubercles are somewhat more crowded and more distinctly connected by longitudinal ribs in *M. (M.) bergeri*.

The relationship between *M. (M.) dorsetensis* and *M. (M.)*

lewesiensis (Spath, 1926) is a moot problem, as has been discussed by Kennedy (1971, p. 28) and Klinger and Kennedy (1978, p. 31). The difficulty can be guessed from the confused state in the lists of synonymy between authors (even between the same palaeontologist writing on different dates) (see Wright and Kennedy, 1996, p. 339–340 and p. 344). Collignon (1964, pl. 331, fig. 1482) has shown an example of *M. (M.) dorsetensis* with a rostrate last whorl. This suggests the small size of this species. We notice, however, that an example of the same species illustrated by Atabekian (1985, pl. 6, fig. 6, 6b) is nearly as large as the holotype of *M. (M.) lewesiensis* (see Sharpe, 1857, pl. 20, fig. 10 or Wright and Kennedy, 1996, p. 101, fig. 3). There is no difference in the estimated apical angle between the two species. There may be differences in the ornament. The relative smoothness of the upper face of the whorl was regarded as a criterion by which to distinguish *M. (M.) lewesiensis* from *M. (M.) dorsetensis*, but some of the coarse tubercles of the first row in the former show faint elongations on a part of the upper whorl face, depending probably on the mode of lighting (see Kennedy, 1971, pl. 8, figs. 1, 4, 5, 8). Wright and Kennedy (1996, p. 340) have recently given their opinion that rounded subequal tubercles in the upper two rows plus feeble spiral (i.e. clavate) elongation of the tubercles in the lower two rows characterize *M. (M.) lewesiensis*. Indeed, the tubercles on the outer whorl face are coarse and globular in *M. (M.) lewesiensis* and rather granular but transversely elongated in *M. (M.) dorsetensis*, although there is no marked difference in the number of tubercles to a whorl. For us it is difficult to understand the significance of the "feeble spiral elongation of the lower tubercles". The tubercles of the lower two rows are clavate in the holotype, but the feature is not well shown in the illustration of some other specimens (e.g., Wright and Kennedy, 1996, pl. 100, figs. 23, 27).

According to Klinger and Kennedy (1978, p. 31, pl. 7, fig. F), in *M. (M.) lewesiensis* [= *M. (M.) dorsetensis* in their paper] ribs are absent or only a few traces are discernible on the lower whorl face, although they did not give a photograph of the basal view.

On the lower whorl face of the holotype ribs are extended very faintly from the tubercles of the fourth row (T.M.'s observation at the Natural History Museum, London). This character is also shown on some examples of *M. (M.) lewesiensis* by Atabekian (1985, p. 37, pl. 7, fig. 1, 1b; pl. 8, fig. 1, 1a), whereas ribs are distinctly developed on the lower whorl face of *M. (M.) dorsetensis* from the Kopet Dag (see Atabekian, 1985, p. 35, pl. 6, fig. 6, 6b) as well as in our specimens (e.g., Figure 1-4 of this paper). If this difference is confirmed in a sufficient number of specimens, it would become one of the reliable criteria to distinguish the two species.

So far, an undoubted example of *M. (M.) lewesiensis* is not found in the material of the Soeushinai area. The specimens which were tentatively identified with *M. lewesiensis* by A.I. (as written on the labels) are actually *M. (M.) oehlerti* (Pervinquier).

Mariella (Mariella) oehlerti (Pervinquier, 1910)

Figures 2-4

Turritiles gresslyi Boule, Lemoine and Thévenin, 1907 (*non* Pictet and Campiche, 1861), p. 57, pl. 13, fig. 2, 2a.

Turritiles oehlerti Pervinquier, 1910, p. 53, pl. 5, figs. 14-17; Collignon, 1929, p. 65, pl. 6, figs. 16, 17; Matsumoto, 1938, p. 23, pl. 2, fig. 7; Collignon, 1964, p. 15, pl. 320, figs. 1398, 1399.

Mariella (Mariella) oehlerti (Pervinquier, 1910); Förster, 1975, p. 190, pl. 7, figs. 7, 8; text-fig. 52; Atabekian, 1985, p. 30, pl. 6, figs. 4, 5; Wright and Kennedy, 1996, text-fig. 138 J,O,V.

Mariella (Mariella) oehlerti oehlerti (Pervinquier, 1910). Klinger and Kennedy, 1978, p. 31, pl. 3E; pl. 4E; pl. 6H-N; pl. 7G; pl. 8G-H; text-figs. 1A, B; 7B, D; 8G.

Mariella (Mariella) oehlerti sulcata Klinger and Kennedy, 1978, p. 33, pl. 8, fig. D; text-figs. 3E, 8H (? *non* pl. 3D; text-fig. 3D).

Holotype.—The specimen figured by Pervinquier (1910, pl. 5, fig. 16) from the Cenomanian of Aumale, Algeria (by original designation). Klinger and Kennedy's (1978, p. 31) designation of a lectotype (Pervinquier, 1910, pl. 5, fig. 15) was misleading, and Atabekian (1985, p. 30) erroneously followed them.

Material.—A large number of specimens from the Member My3 of the Soeushinai area are referable to this species. The representative ones among them are as follows: GK. H8500 (Figure 2-1) and GK. H8501 obtained by T.M. at loc. R518p5 and GS. 166 (Figure 2-7) collected by Y.K. at loc. R518pl from the East Suribachi-zawa; TKD 30086A (Figure 3-2), TDK 30086B (Figure 3-3) and TKD 30086C (Figure 2-6) obtained by A.I. from a nodule at loc. 81001 in the Suribachi-zawa; TKD 30546B (Figure 2-2) and A collected by W. Hashimoto from a nodule at loc. P2 in the River Shumarinai and provided to A.I. for study; GS. G163 (Figure 2-3) and GS. G164 (Figure 2-4) collected by Y.K. at loc. YKC060824 in the Sanjussen-zawa; GS. G165 (Figure 2-5) collected by Y.K. at loc. YKC050610 in the Bishamon-zawa; GS. G167 (Figure 3-1) collected by Y.K. at loc. YKC591014 and also GS. G168 (Figure 4-1) and GS. G169 (Figure 4-2) collected by Y.K. at loc. YKC020619 in the Kyoei-Sakin-zawa.

Description.—Although completely preserved specimens are hard to come by larger examples are approximately estimated at 250 mm in total whorl height and 70 mm in diameter of the last whorl. Several specimens which preserve the rostrum suggest a size dimorphism. The above larger ones, as represented by GS. G168 (Figure 4-1), may represent a macroconch, whereas GS. G167 (Figure 3-1) and TKD 30086A, B (Figure 3-2, 3) may be microconchs, for they are half of the macroconch in size. The rostrate peristome of a larger form, exemplified by GS. G169 (Figure 4-2), is twice as large as that of a smaller form, e.g., TKD 30086C (Figure 2-6).

The apical angle is low but seems to be somewhat variable between individuals and probably also with growth. On account of incomplete preservation, the actual angle is hard to measure with precision. It is roughly estimated at 25° (±5°) on the average.

The whorl is asymmetrically subquadrate to broadly rhomboidal in section. Its upper flank [i.e. upper part of the

exposed whorl face] slopes down, forming an obtusely angular (costal) or a subrounded (intercostal) shoulder at the first row of tubercles; its middle flank [i.e., main part of the exposed whorl face] is nearly vertical and forms an obtuse shoulder at the second row of tubercles with the narrow, lower flank which inclines steeply inward; the whorl junction is thus fairly deep and crenulated. The aperture is suboval and provided with a rostrum that extends at first downward and then recurves obliquely upward (see Figures 3-3; 2-6; 4-1, 2).

The tubercles are moderate in strength and coarseness; those of the first row are more prominent than others and extend upward to the ribs on the upper flank. Those of the three rows on the exposed whorl face are nearly equidistant, arranged more or less obliquely and sometimes connected by blunt riblets; those of the third row may be granular or sometimes rather clavate (i.e. extended spirally); the interspace between the second and third rows of tubercles is sometimes narrower than that between the first and second rows and, furthermore, it may be grooved to various depths (see Figure 2-5). The tubercles of the fourth row are close to those of the third row in some specimens but they are disposed along the outer margin of the basal part of the whorl. The tubercles of each row in our sample normally number from 20 to 28 to a whorl. TKD 30546B (Figure 2-2) may exemplify an extreme case (30 to a whorl), but it is referred to this species in consideration of other characters.

Aside from the bullate extension to the ribs, the tubercles of the upper two rows are conical with a rounded base. In some cases they may preserve a sharply pointed summit, but so far a highly extended spine has not been observed in our material.

Near the apertural margin the tubercles are obliquely bullate and extended to gently flexuous narrow ribs. The last rib goes on to form a blunt ridge on the rostrum, whereas the other side of the rostrum is ornamented by very fine and delicate riblets and dots (see Figures 2-6a, b, 4).

The septal suture is not well traced in our material, because the internal mould is not well exposed. It was illustrated by Förster (1975, fig. 52) on a young example from Mozambique and partly by Klinger and Kennedy (1978, fig. 1A, B) on middle-aged specimens from South Africa.

Comparison and discussion.—As the types originally described by Pervinquier (1910) and also the specimens dealt with by subsequent authors up to 1975 are so small it was difficult for us to understand the diagnosis of this species.

Based on a great number of specimens from the Lower Cenomanian of South Africa, Klinger and Kennedy (1978) have clarified the diagnosis of this species and also its relations with or distinctions from other species. Wright and Kennedy (1996, text-fig. 138 J,O,V) have finely reillustrated Pervinquier's holotype and paratypes. These two works have enlightened us in getting a proper conception of *M. (M.) oehlerti*.

In our material there are specimens which closely conform with the holotype. GK. H8500 (Figure 2-1) is such an example. They are, however, immature. The full-grown adult shell has a rostrate aperture. The three specimens illustrated in Figure 3 exemplify the adult shells of moderate size,

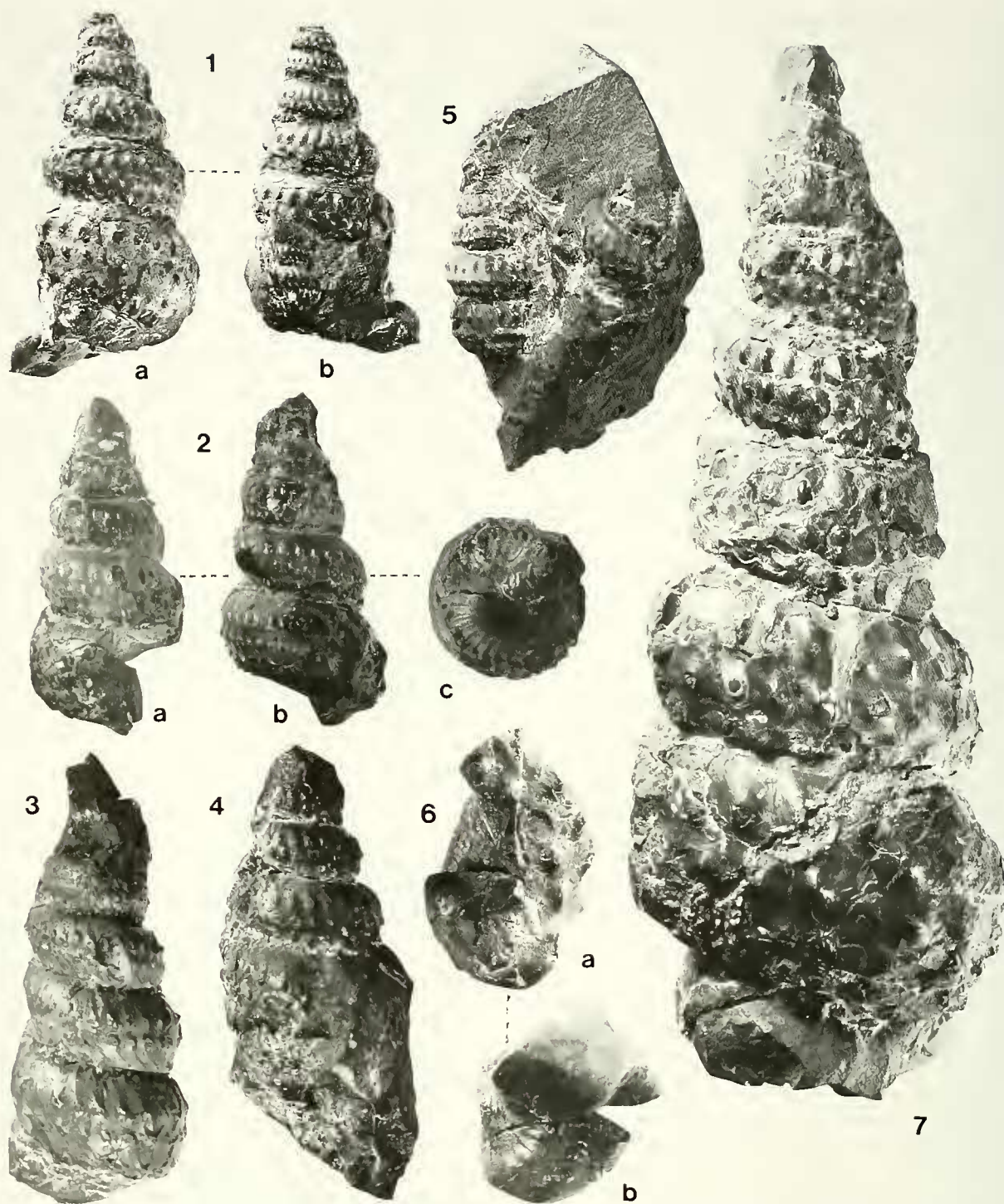


Figure 2. *Mariella (Mariella) oehlerti* (Pervinqui re). **1a, b.** GK. H8500, two lateral views, $\times 1.2$ (The terminal protuberance is not a rostrum but an attached juvenile of *Anagaudryceras* sp.). **2a-c.** TKD 30546B, two lateral and basal views, $\times 1.5$. **3.** GS. G163, $\times 1.5$. **4.** GS. G164, $\times 4/3$. **5.** GS. G165, $\times 4/3$. **6a, b.** TKD 30086c, detached rostrum, external and the other sides, $\times 1$. **7.** GS. G166, a large but incomplete example, $\times 1$.

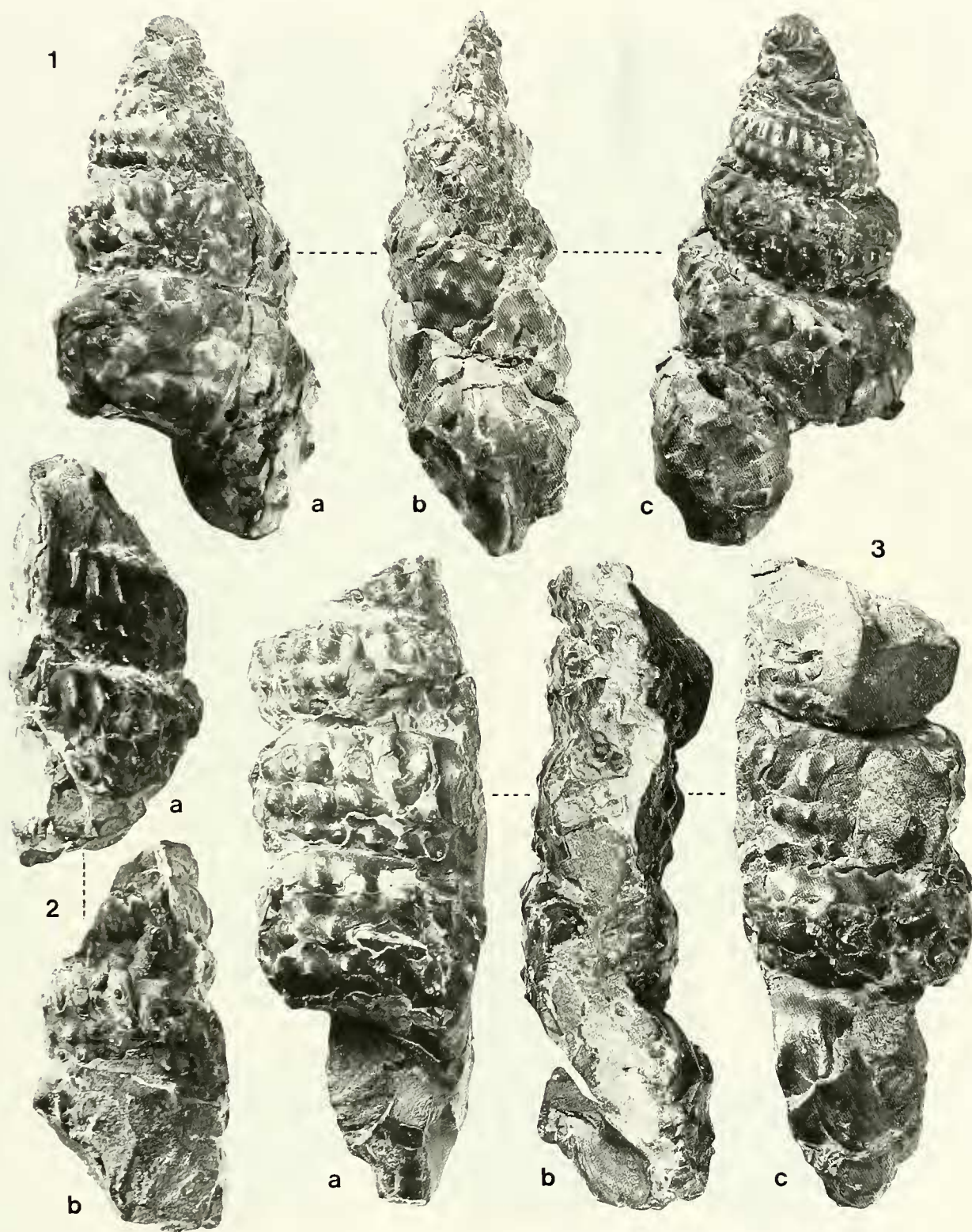


Figure 3. *Mariella* (*Mariella*) *oehlerti* (Pervinquière). More or less deformed examples of a smaller form with a rostrate peristome, all $\times 1$. 1a-c. GS. G167, three lateral views. 2a, b. TKD 30086A, two lateral views. 3a-c. TKD 30086B, three lateral views.

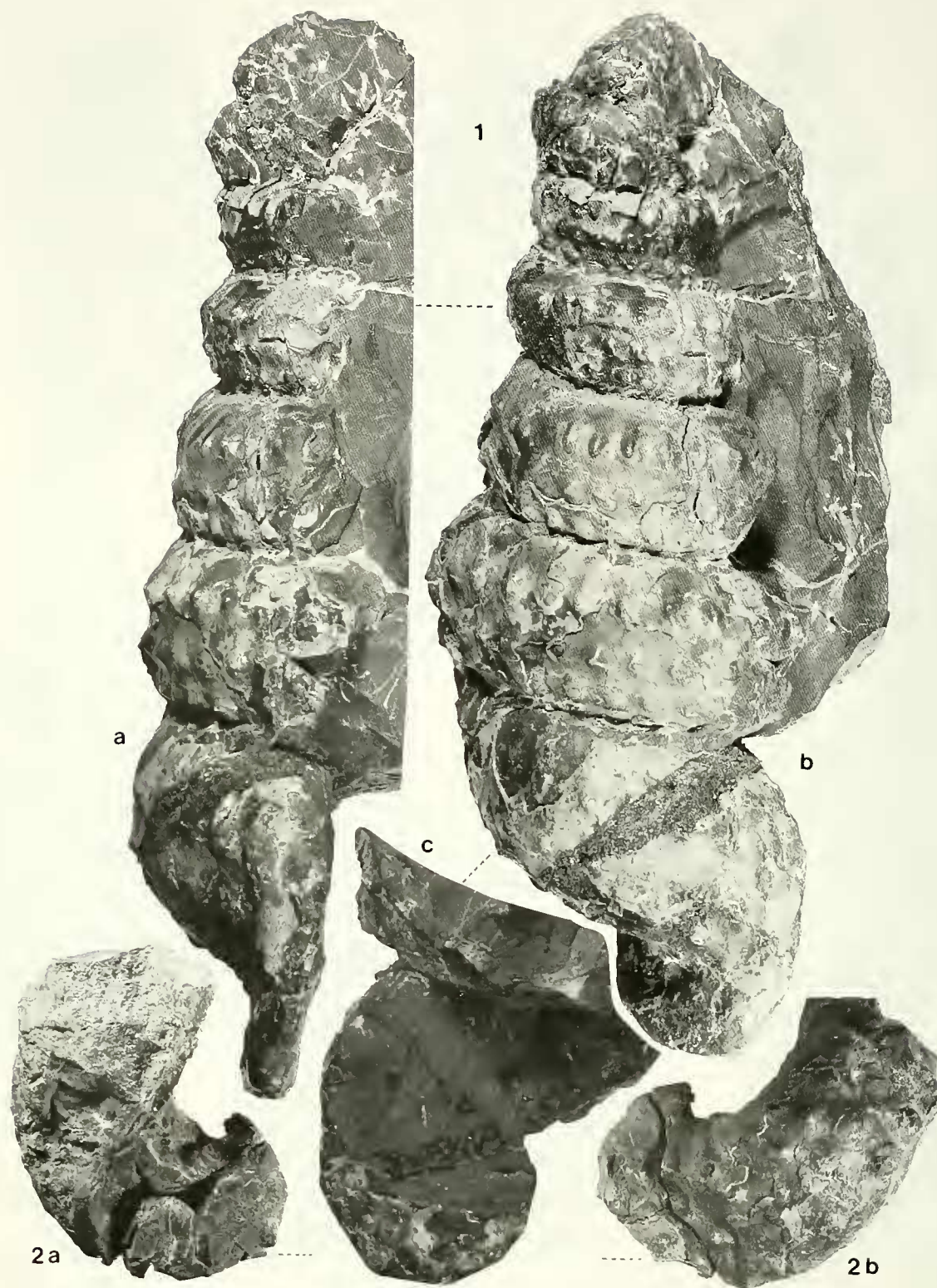


Figure 4. *Mariella (Mariella) oehlerti* (Pervinquière). Examples of a larger form, $\times 0.9$. **1a c.** GS. G168, two lateral views (a, b) and aperture (c). **2a, b.** GS. G169, two views of a detached rostrum.

although they are considerably affected by secondary deformation. Among a number of South African specimens, BMNH C79806 (Klinger and Kennedy, 1978, pl. 6, fig. K) is an illustrated example of the adult stage. It is similar in size to our examples mentioned above, but it preserves only two whorls of the late growth stage.

In our material from the Member My3 there are much larger adult specimens which preserve the rostrate oral part. GS. G168 (Figure 4-1) is an example of such a large form. It is nearly twice as large as the specimens mentioned above. GS. G166 (Figure 2-7) is referable to a similarly large form, although its later part is not preserved. GS. G169 (Figure 4-2) is a detached piece of a rostrate oral part. It is nearly twice as large as TKD30086C (Figure 2-6), which is a detached oral part of a smaller form.

The facts described above suggest the existence of a dimorphic pair in this species. To confirm the dimorphism, it is necessary to get further evidence from the materials of other regions. Although "several hundred specimens" of this species from South Africa have been treated by Klinger and Kennedy (1978, p. 32), they did not make mention of the size variation or dimorphism. The specimens figured by them are more or less incomplete, consisting of a few whorls. The largest example among them is BMNH C79860 (*op. cit.*, pl. 8, fig. H). [Note that figure is actually $\times 5/4$, although it was indicated as $\times 1$.] It could be comparable with a part of the large specimen (GS. G168, Figure 4-1) from Hokkaido, but it lacks the oral end. On the other hand, a specimen from South Africa (*op. cit.*, pl. 6, fig. K) which possesses an incomplete rostrum is comparable with the smaller form from Hokkaido.

Dimorphism in the Turritidae has been noted by Wright and Kennedy (1996, p. 349) for *Turritites scheuchzerianus* Bosc and certain other species, but Lehmann (1998, p. 37) has given comments and suggested that the observed difference might simply be size variation. There could be, however, size variation in both microconch and macroconch. For a final conclusion one should examine a sufficient number of samples.

There is another problem to be discussed. Some specimens of *M. (M.) oehlerti* from the Member My3 of the Soeushinai area show a spiral sulcus between the second and third rows of tubercles. In such cases, the tubercles rest on low ridges and may be obliquely clavate. The groove is thus variable in its degree of distinctness among the specimens and the sulcate specimens often occur together with normal ones. This feature is similar to that already noticed in the material of South Africa. Klinger and Kennedy (1978, p. 33, pl. 3, fig. D; pl. 8, fig. D; text-figs. 3D, D; 8H) have established a subspecies *M. (M.) oehlerti sulcata*. One of us (T.M.) examined some of the specimens labelled as "*M. (M.) oehlerti sulcata*", such as BM. C79952 (*op. cit.*, pl. 8, fig. D), C79951, C79950 and C79949. They seem to show a gradual change in morphology from "*M. (M.) oehlerti oehlerti*" to "*M. (M.) oehlerti sulcata*."

The holotype of the subspecies *M. (M.) oehlerti sulcata* Klinger and Kennedy, 1978 is SAS A2908. Although we have yet no opportunity to examine the actual specimen itself, its fine illustration (*op. cit.*, pl. 3, fig. D) gives us a strong

impression that it resembles a form of *Mesoturrilites aumalensis* (Coquand) such as was figured by Pervinquière (1910, pl. 14, fig. 22) (see Wright and Kennedy, 1996, text-fig. 138 S-T). Furthermore, we see that the specimen in question (SAS A2908) is similar to, if not identical with, *Mariella (Mariella) bicarinata* (Kner, 1852) (see Atabekian, 1985, p. 40, pl. 8, figs. 2-9; pl. 9, figs. 1, 2; Wright and Kennedy, 1996, p. 335, pl. 98, figs. 7, 12; pl. 102, fig. 11). We are thus, inclined to consider that it would be better to exclude the holotype of *M. (M.) oehlerti sulcata* from *M. (M.) oehlerti*. Incidentally, the above observation may be favourable to the suggestion of Wright and Kennedy (1996, p. 346) to seek the origin of *Mesoturrilites* in *M. (M.) bicarinata*.

Occurrence.—As for material. In addition, incompletely preserved specimens which can be called *M. (M.) cf. oehlerti* are found commonly in the Member My3 of the Soeushinai area. At least some of the specimens, including GK. H8500 and H8501, occur in the lower part of the Member My3 together with *Graysonites adkinsi* Young.

Records of this species from other areas in Hokkaido are so far poor, except for a fine specimen MCM A517 collected by Reishi Takashima and Koji Hasegawa from the Oyubari area. This is to be reported in detail on another occasion.

Outside of Hokkaido in Japan a few small specimens of this species were described by Matsumoto (1938, p. 23, pl. 2, fig. 7) from the Unit IIe of the mid-Cretaceous Goshonoura Group of Kyushu; *Graysonites cf. fountaini* Young occurs in the same unit (Matsumoto, 1960, p. 44, pl. 6, fig. 1; pl. 7, figs. 1-4; text-figs. 1-7, with Matsumoto *et al.*, 1960, p. 51).

M. (M.) oehlerti has been reported from the Lower Cenomanian of Algeria, Madagascar, Mozambique, South Africa and Turkmenistan (Kopet Dag) (see references in the synonymy list). The record of its occurrence in the Gulf Coast (Texas and Mexico) (Young and Powell, 1978, pl. 8, figs. 4, 6) is not clear. As species of *Graysonites* occur there, undoubted example of *M. (M.) oehlerti* should be searched for.

Mariella (Mariella) pacifica sp. nov.

Figure 5

Material.—Holotype is GS. G170 (Figure 5-1) from a nodule contained in the siltstone of the middle part of the Member My3, collected by Y.K. and N. Egashira at loc. R905 of the Hotei-zawa, a branch stream of the River Shumarinai, Soeushinai area (see Figure 7 in the Appendix).

In the same nodule as that of the holotype there are ten specimens, of which registered paratypes are GS. G171 (Figure 5-2), GS. G172 (Figure 5-3), GS. G173 (Figure 5-4), GS. G174 (Figure 5-5), GS. G175 (without figure), GS. G176-G177 (Figure 5-6), GS. G178 (Figure 5-7) and GS. G179 (without figure). Unregistered specimens are recorded from R906, at a slightly higher horizon than R905.

TKD30558 (Figure 5-8) and TKD30559 (Figure 5-12) from a nodule at loc. P4 and TKD30561A, B (Figure 5-9, 10) from a nodule at loc. P2, all taken by W. Hashimoto and transferred to A.I. for study, are probably derived from the Member My3 exposed along the middle course of the River Shumarinai.

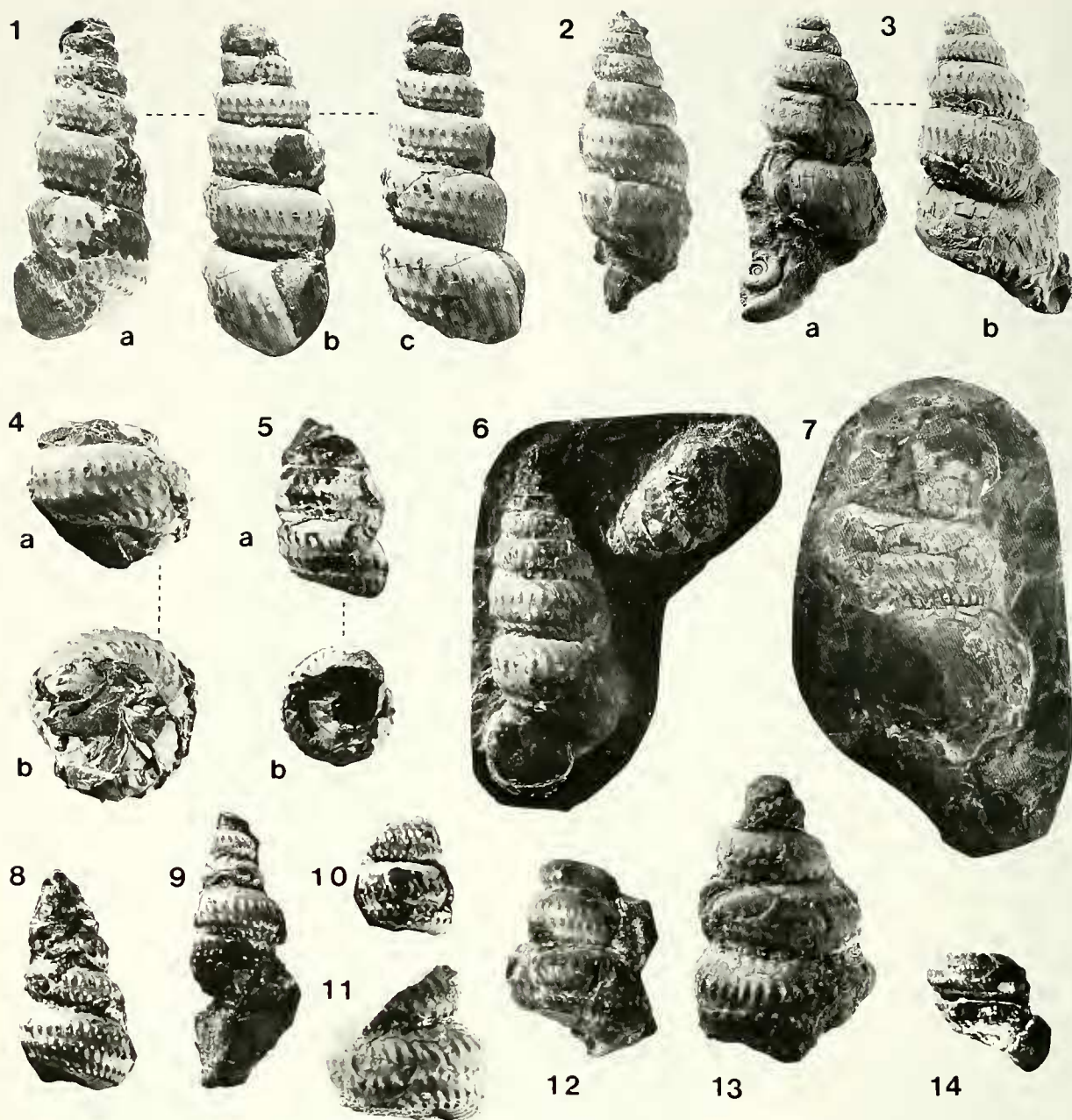


Figure 5. *Mariella (Mariella) pacifica* sp. nov. **1a c.** Holotype, GS. G170, three lateral views, $\times 1.5$. Note that the upper whorl of the holotype is encrusted with some other organism. **2.** GS. G171, with a rostrate oral part, $\times 4/3$. **3a, b.** GS. G172, with a rostrate oral part where a juvenile *Anagaudryceras* sp. is attached, $\times 1.5$. **4a, b.** GS. G173, lateral and basal views, $\times 2$. **5a, b.** GS. G174, lateral and basal views, $\times 1.5$. **6.** GS. G176 and G177 (obliquely embedded), $\times 1.5$. **7.** GS. G178, deformed larger form with a rostrate oral part, $\times 4/3$. **8.** TKD 30558, $\times 1.5$. **9.** TKD 30561A, $\times 1.5$. **10.** TKD 30561B, $\times 1.5$. **11.** GK. H8503, $\times 2$. **12.** TKD 30559, $\times 2$. **13.** GK. H8502, $\times 2$. **14.** TKD 30560, $\times 2$. TKD 30560 is tentatively called *Mariella (Mariella)* aff. *pacifica*.

GK. H8502 (Figure 5-13) and GK. H8503 (Figure 5-11) obtained by T.M. at loc. R518 p5 of the lower part of the Member My3 in the East Suribachi-zawa, are probably referable to this species, although they are incompletely

preserved.

Diagnosis.—Small, sinistrally coiled and slenderly shaped *M. (Mariella)*, ornamented densely by numerous, small tubercles and delicate riblets in four rows at unequal intervals,

Table 1. Measurements of *Mariella* (*M.*) *pacifica*.

Specimen Whorl	GS. C170 (holotype)				G171		G172
	1°	2°	3°	4°	2°	3°	3°
Diameter	15.2	13.0	11.2	9.3	13.0	10.8	12.8
Height	9.6	7.5	5.7	4.3	7.0	4.6	6.2
H./D.	.63	.58	.51	.46	.54	.43	.48
Ribs	32	33	33	31	32	33	32

Height means the distance between the upper and lower seams at the adoral end of the measured whorl. Rib means the number of ribs or tubercles per whorl. 1°, 2°, indicate the first, second, whorls in ascending order from the bottom. Note that an undeformed whorl is selected for the measurements. Linear dimensions are in mm.

with the interspace between the first and second rows at about the mid-flank. Ribs extend upward from the tubercles of the first row; often the tubercles of the second and third rows closely but obliquely disposed, forming weak spiral ridges with a narrow groove in between; the extended fine riblets recurved on the basal surface by way of the fourth tubercles.

Description.—The shell is small and slender; its apical angle is apparently low (less than 30°); junction of whorls rather shallow; whorl section suboval to subrhomboidal, with outward sloping and gently convex upper portion of flank, nearly flat or slightly convex main part of flank, and narrow and inward-sloping lower portion. Obtuse shoulders may thus be formed at the upper and lower edges of the main part of flank. Basal surface of the whorl is gently convex, sloping to a narrow umbilicus.

Ornament consists of numerous, densely set, fine tubercles and extended delicate riblets, numbering about 30 to 40 to a whorl in each row. The tubercles are normally in four rows at unequal intervals; the first row slightly above the mid-flank, the second somewhat below the mid-flank, the third close to the second and the fourth along the lower whorl seam on the outer margin of the basal surface, where riblets are recurved. The tubercles are of unequal intensity between the rows; those of the first row are slightly coarser than others and extend upward to short ribs; those of the second and third rows are finer, somewhat oblique and disposed en echelon; often they appear to form blunt spiral ridges with a sulcus in between. The tubercles of the fourth row are very fine and close to those of the third row; occasionally the fourth-row tubercles are scarcely discernible or undeveloped.

Near the apertural margin ribs become flexuous and continuous, connecting transversely elongates tubercles (see GS. G171, G172 and G178; Figure 5-2, 3, 7). Regrettably, the recurved part of the rostrum is not preserved. At any rate, the above three specimens represent the adult shell. The holotype (GS. G170) is also nearly adult. The three specimens, GS. G170, G171 and G172 (Figure 5-1-3) are equally small, with total whorl heights about 40 mm and diameters of last whorl 15 mm or so. On the other hand GS. G178 (Figure 5-7) is somewhat larger, although it is deformed and lacks earlier whorls. Again dimorphism can be considered, if not definitely confirmed.

Measurements.—See Table 1.

Comparison.—In respect of a small and slender shell with

numerous, fine and delicate tubercles and riblets, this species may be closely allied to *M. (M.) numida* (Pervinquier) (1910, p. 53, pl. 5, figs. 12, 13), from the Cenomanian of Algeria, but the holotype of that species (refigured by Wright and Kennedy, 1996, text-fig. 138L) is dextral and seems to possess a lower apical angle (about 18°) and four rows of tubercles wholly exposed on the outer face of a whorl. For the exact comparison more specimens including an adult example of *M. (M.) numida* are required.

In having numerous tubercles and obliquely extended riblets, *M. (M.) pacifica* is apparently similar to *M. (M.) torquatus* Wright and Kennedy, 1996 (p. 334, pl. 100, figs. 2, 20, 21), from the Lower Cenomanian of England. In the latter the rows of closely set tubercles form distinct spiral ridges. In the former the tubercles are normally not so much crowded and the ridges are weaker. TKD30560 (Figure 5-14) from loc. P1 is exceptional in that its tubercles and riblets are so crowded and numerous (about 50 to a whorl) that the rows of tubercles form fairly distinct spiral ridges. There is, however, some extent of variation in the distinctness of the ridges in *M. (M.) pacifica*. For instance, TKD30559 (Figure 5-12) and TKD30558 (Figure 5-8) appear to show intermediate features. There is, thus, a certain extent of variation in the fineness of tubercles and appearance of ridges in *M. (M.) pacifica* and also in *M. (M.) torquatus* (see the three figures cited above). The undoubted difference between the two species is in the disposition of the rows of tubercles. Namely, in *M. (M.) torquatus* the first row is higher in the upper part of the whorl face and the second row is at the middle of the whorl, whereas in *M. (M.) pacifica* the interspace between the first and second rows is at the mid-flank. This is maintained even in TKD30560. There is also a difference in whorl shape between the two species; rectangular versus suboval in whorl section.

In respect of the small and slender shell, *M. (M.) pacifica* is somewhat similar to *M. (M.) camachoensis* (Böse) (1923, p. 149, pl. 10, figs. 32-37) (see also Clark, 1965, p. 43, pl. 13, figs. 6, 8; pl. 18, fig. 8), from the Upper Albian (a unit correlatable with the Pawpaw Formation) of Mexico, but the tubercles of *M. (M.) pacifica* are more numerous and disposed in rows at unequal intervals; those of the first row are coarser and extended upward to ribs.

M. (M.) pacifica resembles *M. (M.) oehlerti* (Pervinquier) (*vide supra*) in general appearance and especially in the disposition of the rows of tubercles. The former is characterized by its slender shell shape, with a shallower inter-

whorl junction, suboval instead of subquadrate to rhomboideal whorl section and on the average finer, denser and more numerous tubercles and riblets in comparison with the latter. Should the suggested dimorphism be warranted in each of the two species, the size difference at the adult stage would be distinctive.

Klinger and Kennedy (1978) found in their South African material of *M. (M.) oehlerti* large variation in the number of tubercles. The number ranges from 15 to 28 per whorl with an exceptional 30; for the majority the range is from 18 to 24. This is conformable with our material of *M. (M.) oehlerti*. In the case of *M. (M.) pacifica* under investigation, the counted range is normally from 30 to 40 per whorl. The two species are thus separable on this point, although the range is fairly wide in each of them. However, TKD30560 mentioned above (with 50 tubercles per whorl) is rather extreme and it is better to call it tentatively *M. (M.)* aff. *pacifica*.

With respect to numerous, densely set tubercles, *M. (M.) miliaris* (Pictet and Campiche, 1861) (p. 136; 1862, pl. 58, fig. 5) (see Renz, 1968, p. 88, pl. 18, fig. 10 for the reillustration of holotype) is somewhat similar to *M. (M.) pacifica*, but the rows of tubercles are nearly equidistant and the apical angle has been described as larger in that species. It is closely related to *M. (M.) bergeri*, as Spath (1937, p. 515) has already mentioned. *M. (M.) miliaris* normally occurs in the Upper Albian but ranges up to the Lower Cenomanian in England (see Wright and Kennedy, 1996, p. 333).

Occurrence.—As for material. The type locality is in the middle part of the Member My3. This species occurs so far in the Lower Cenomanian of Hokkaido. Its true vertical range and geographical distribution should be determined by further investigations.

Acknowledgments

For the material of this palaeontological study we are indebted to the cooperative field work conducted by W. Hashimoto and also by T. Nishida. We have been much enlightened by the results of previous palaeontological studies, especially those by Clark (1965), Klinger and Kennedy (1978), Atabekian (1985) and Wright and Kennedy (1996), although our views may not be always agreeable with them. Naoko Egashira and Seichi Toshimitsu helped us in photography and Kazuko Mori assisted us in preparing the manuscript.

Appendix

Locality guide for selected Cretaceous fossils of the Soeushinai area

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The localities of the Cretaceous fossils in the Soeushinai area and the lists of identified species (mainly Mollusca and Foraminifera) have been indicated in a number of route maps

and tables in the papers by Nishida *et al.* (1992, 1993, 1996, 1997, 1998a, b). These papers are written in Japanese and the maps are too numerous. Hence, two comprehensive maps (Figures 6 and 7) are presented here. They are compiled from some of the previous maps with necessary modifications. The specimens of *Mariella* species with register numbers in the descriptions and a few unregistered ones are indicated in the maps. Moreover, the maps contain localities of selected mid-Cretaceous guide species which are particularly important for interregional correlation.

The geology is outlined in the maps. A thick broken line is a fault and a dotted line is a boundary of lithostratigraphic units. The Lower Yezo and Middle Yezo Subgroups are abbreviated to Ly and My. My1, My2, My3 and so on are successive members of My; T is the Tertiary (mainly Miocene); Q is a leucocratic intrusive body. A megafossil locality is indicated by a small solid circle (in situ) or by a cross mark (fallen or transported nodule).

Notes are briefly given below in accordance with the investigated routes, of which (1)–(3) are shown in Figure 6 and (4)–(10) in Figure 7.

(1) *Main course of the River Sounnai* (part) (upstream).—R887 (a nodule derived probably from the upper part of Ly): *Hysterocheras orbigny* (Spath), *Pseudohelicocheras* sp. etc. R880 (nodules in mudstone in the upper part of My1): *Mortoniceras* (*Deiradoceras*) sp., etc. R34 (mudstone alternated with sandstone, lower part of My2): *M. (Durnovarites)* cf. *subquadratum* Spath etc. R803 (laminated mudstone and sandstone, upper part of My2): *Mariella bergeri* (Brongniat), *Mortoniceras* (*M.*) cf. *minor* Spath. R813 (ditto): *M. bergeri*, *Bhimaites kawai* Matsumoto and Egashira. The above faunules at four levels are correlated with successive zones of the Upper Albian.

(2) *East Suribachi-zawa* (E in Figure 6).—R525 (laminated mudstone in the upper part of Member My2): *Bhimaites* cf. *kawai* and *Inoceramus* n. sp. (small, nearly equivalve, finely ornamented species, probably identical with the late Albian species from Mont Risou illustrated in Gale *et al.*, 1996, figs. 21f, j; 31g). R520 (nodules derived from the basal part of My3): *Mariella* aff. *bergeri* (to be described in Part 2), *Graysonites adkinsi* Young, *Stoliczkaia* (*Lamnayella*) *sanctaechatherinae* Wright and Kennedy etc. R518 (nodules from the lower part of My3): *Mariella oehlerti*, *M. dorsetensis*, *M.* cf. *pacifica* etc. R515 (mudstone in the lower part of My3): *Graysonites* sp.

(3) *Suribachi-zawa* (S in Figure 6 and branch rivulets) (upstream).—R875 (a nodule derived from My3): *Mariella miliaris* (Pictet and Campiche) (to be described in Part 2). A181001 (nodule from My3) and R543 (nodules in mudstone of My3): *M. oehlerti* etc. R575 (ditto): *M. dorsetensis*, *M. oehlerti*, *Graysonites* cf. *adkinsi* (nearby derived nodule). *Inoceramus* aff. *reachensis* Etheridge. R534 (nodules in laminated sandstone and mudstone of My2): *Inoceramus* n. sp. (same as sp. at R525), *Mortoniceras* cf. *minor* etc. R433 and I481007 (nodules from My3): *M. dorsetensis*, *Stoliczkaia* (*Lamnayella*) cf. *sanctaechatherinae* etc. R438 (nodules from My3): *M. dorsetensis* etc. R471 (mudstone of My3): *Inoceramus* aff. *reachensis*. R449 (nodule from My3?): *M.* cf. *carrancoi* (Böse) (to be described in Part 2). R456 (nod-

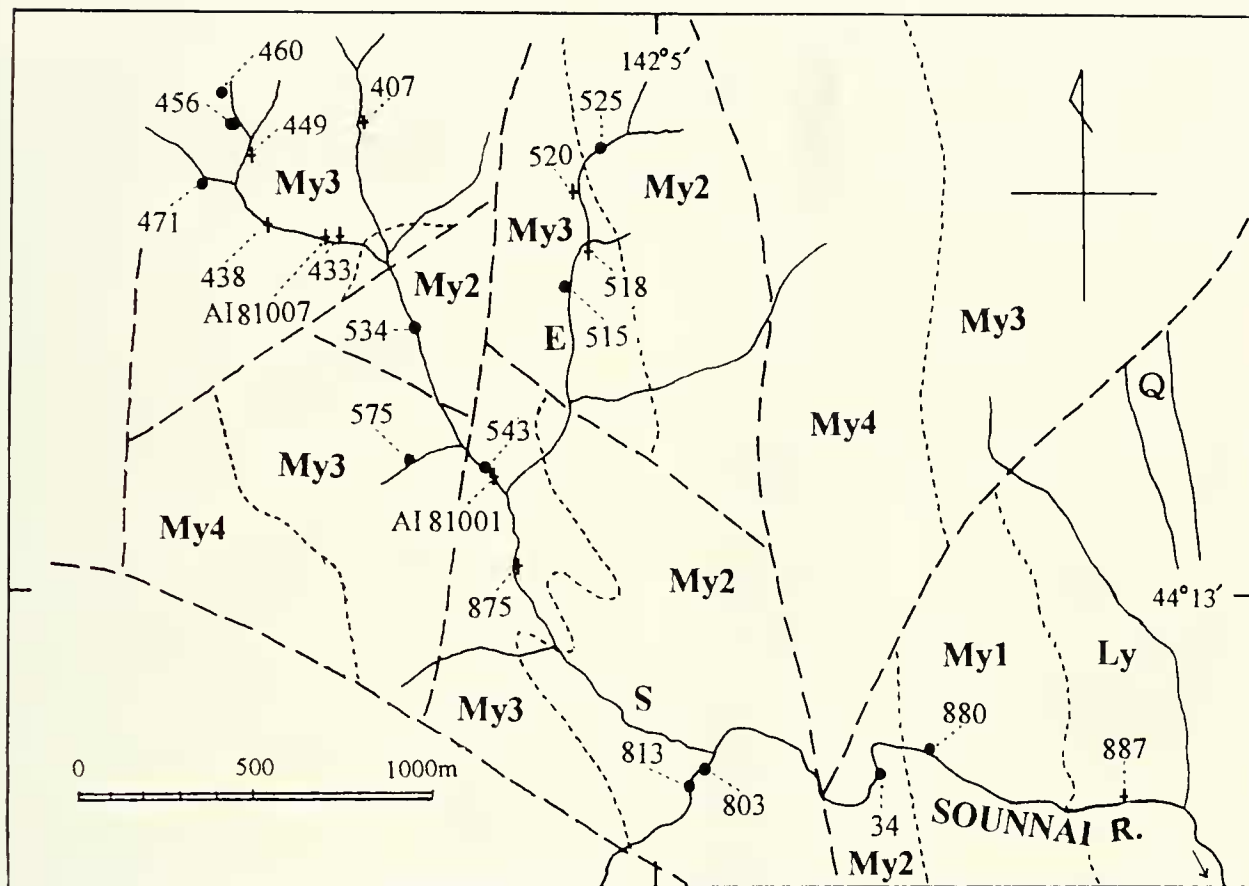


Figure 6. Route map of the Suribachi-zawa and part of the Sounnai River, showing localities of *Mariella* and selected guide species (compiled from Nishida *et al.*, 1996, figs. 3-5 and 8 and also Nishida *et al.*, 1997, figs. 1, 2). See text for the marks and abbreviations. Some of the numbered localities with prefix AI are referred to TKD specimens. Many others are concerned with the main material of this study. They should have the prefix R, which is omitted in this and the other map for brevity. Note that prefix AI is not used in the original label of TKD and in the main text of this paper.

ule in sandy siltstone of My3): *M. dorsetensis*, *Stoliczkaia* (*Lamnayella*) cf. *amanoi* Matsumoto and Inoma. R460 (nodule in mudstone of My3): *M. oehlerti*, *Graysonites* cf. *adkinsi*. R407 (nodule from My3): *M. cf. pacifica*.

(4) NW branch rivulet of the Sanjussen-zawa.—Loc. YKC060824 (nodule from My3): *M. dorsetensis*, *M. oehlerti* etc.

(5) Upper reaches of the Kyoei-Sakin-zawa.—At two localities YKC591014 and YKC020619 *Mariella oehlerti* was collected in nodules from My3. Not far from these localities *Graysonites wooldridgei* was obtained in situ at loc. YKC010618 and in a transported nodule at loc. YKC040808. Somewhat downstream from them at loc. KY768 *S. (L.) sanctaecatherinae* was obtained from a transported nodule. These localities are all in the area of My3. Still further downstream at locs. YKC060918 and KY356 *G. adkinsi* was collected from transported nodules. The two localities suggest a small outcrop of My3 within an otherwise Tertiary area.

(6) Ebisu-zawa and Hotei-zawa (EB, HT in Figure 7).

—R557 and R560 (laminated mudstone and sandstone): *Inoceramus* n. sp. (same as the one from R525). R567 (nodule from My3): *M. cf. oehlerti*. R901 (nodule from My3): *Graysonites wooldridgei*. R905 (nodule in mudstone of My3): *M. pacifica*, *M. dorsetensis* etc. R906 (ditto): *M. pacifica*, *M. gallienii* (Boule, Lemoine and Thévenin), *S. (Lamnayella) sanctaecatherinae*.

(7) Middle course of the R. Shumarinai and a branch rivulet Fukuroku-zawa (FR in Figure 7) (upstream).—R8003 (laminated mudstone and sandstone of My2): *Bhimaites kawai*, *Inoceramus* n. sp. (same as R525). AI71204 (nodule from My3): *M. dorsetensis*. KY350 [=R8054] (nodule in mudstone with sandy laminae of My3): *S. (L.) sanctaecatherinae*. AI P1, P2, P4 (nodules from My3): *M. aff. pacifica*, *M. oehlerti*, *M. pacifica*. R926 (large nodule derived from My3): *M. oehlerti* etc. R917 (nodule from My3): *M. oehlerti*. R919 (nodule in mudstone of My3): *M. oehlerti*, *Ostlingoceras* cf. *bechii* (Sharpe), *Inoceramus* aff. *reachensis* etc. R930 (nodule from My3): *M. oehlerti*, *I. aff. reachensis*. R931 (nodule from My3): *M. cf. oehlerti*.

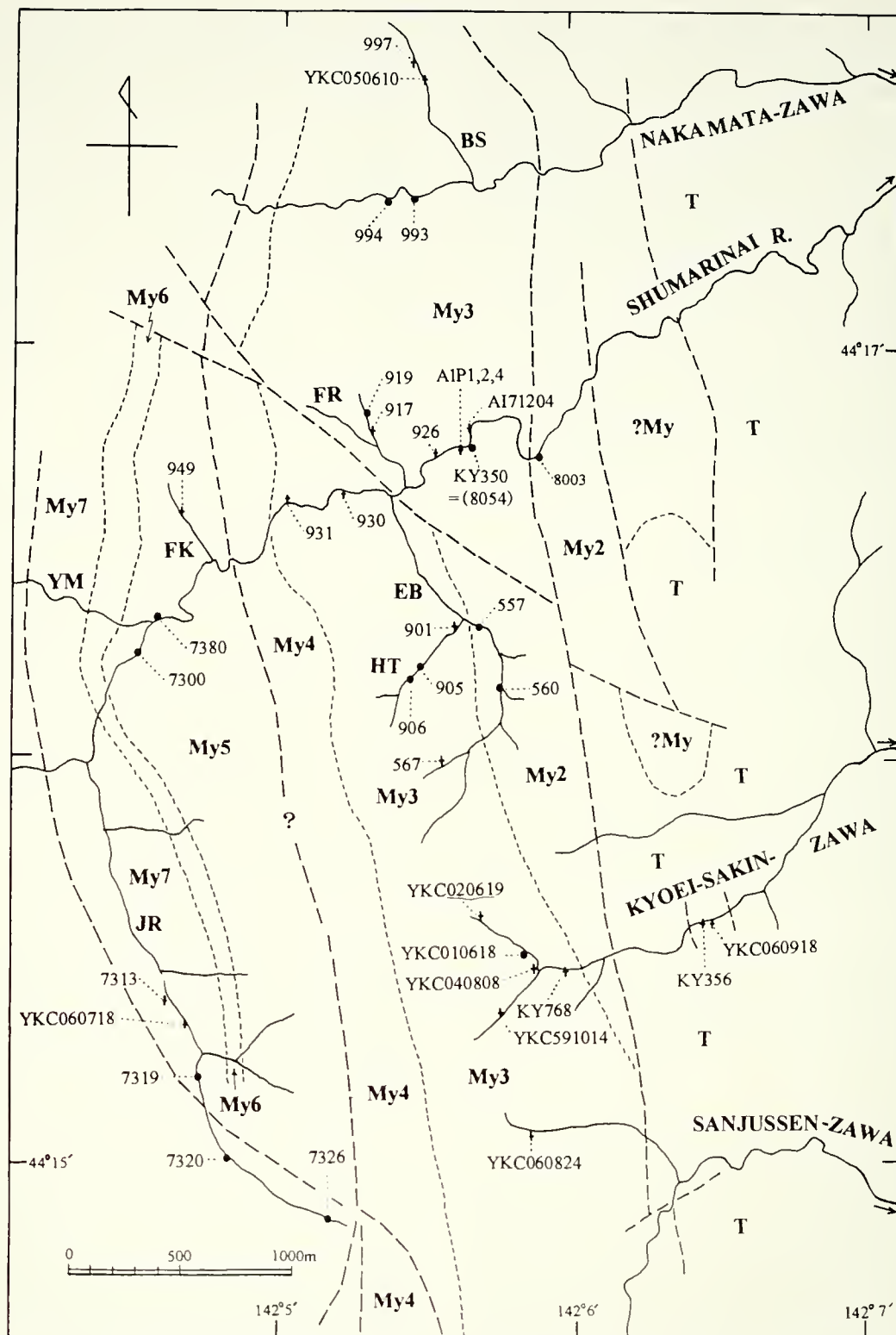


Figure 7. Route map of the area across the middle course of the Shumarinai River, showing localities of *Mariella* and selected guide species (compiled from Nishida *et al.*, 1996, fig. 7; Nishida *et al.*, 1997, figs. 7, 8; Nishida *et al.*, 1998b, figs. 2-4 and 7). See text for the marks and abbreviations. Prefix KY or YKC to a locality number refers to Katsujō Yokoi's or Y.K.'s collections by their independent field work. Other numbers are as for Figure 6.

(8) Middle course of the Nakamata-zawa and its tributary Bishamon-zawa (BS in Figure 7) (upstream).—YKC050610 (nodule derived from My3): *M. oehlerti*. R997 (nodule from My3): *S. (L.) sanctaecatherinae*. R993 (nodule in mudstone of My3): *M. oehlerti*, *M. pacifica*, *Graysonites* sp., *Zelandites* cf. *inflatus* Matsumoto. R994 (nodule in mudstone of My3): *Inoceramus* aff. *reachensis*.

(9) Upper-middle course of the R. Shumarinai and a branch rivulet Fuku-no-sawa (FK in Figure 7) (upstream).—R949 (nodule from lower part of My5): *Turrilites acutus* Passy, *Inoceramus pictus minus* Matsumoto. R7380 (mudstone in the middle part of My5): *Inoceramus ginterensis* Pergament. R7300 (sandy mudstone in the upper part of My5): *Wellmanites japonicus* Matsumoto, Takahashi and Sanada, *Inoceramus* cf. *pennatulus* Pergament etc.

(10) Jyurou-zawa (JR in Figure 7) (upstream).—R7313 (nodule from My7): *Vascoceras durandi* (Thomas and Peron). YKC060718 (nodule from My7): *Muramotoceras yezoense* Matsumoto, *Inoceramus kamuy* Matsumoto and Asai, *Mytiloides subhercynicus* (Seitz), etc. R7319 [=YKC010625] (huge nodules in mudstone of My7): *Pteropuzosia kawashitai* Matsumoto. Based on the above species My7 is referable to the lower part of the Turonian. No species of the Turrilitidae has been found from My7. Being separated by a fault, mudstones with some beds of sandstone are exposed in the uppermost course of the Jyurou-zawa where ammonoids and inoceramids of the upper to middle Cenomanian have been collected at locs. R7320–7326, while turrilitids have yet to be searched for.

We thank A. Inoma, K. Yokoi and Y. Kawashita for their kind information about some localities of their independent collections.

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